

CLAIMS:

We claim:

- 5        1.        A freestanding particle comprising a plurality of segments, wherein the particle length is from 10 nm to 50  $\mu\text{m}$  and the particle width is from 5 nm to 50  $\mu\text{m}$ .
2.        The particle of claim 1, wherein the particle length is from 500 nm to 30  $\mu\text{m}$ .
- 10       3.        The particle of claim 1, wherein the particle length is from 1 to 15  $\mu\text{m}$ .
4.        The particle of claim 1, wherein the particle width is from 10 nm to 2  $\mu\text{m}$ .
5.        The particle of claim 1, wherein the particle width is from 30 nm to 500 nm.
- 15       6.        The particle of claim 1, comprising 2 to 50 segments.
7.        The particle of claim 1, comprised of 2 to 10 different types of segments.
- 20       8.        The particle of claim 1, wherein the lengths of said segments is from 1 nm to 50  $\mu\text{m}$ .
9.        The particle of claim 1, wherein the lengths of said segments is from 50 nm to 15  $\mu\text{m}$ .
- 25       10.       The particle of claim 1, comprising 2 to 50 segments, wherein the particle length is from 1 to 15  $\mu\text{m}$ , the particle width is from 30 nm to 2  $\mu\text{m}$ , and the lengths of said segments is from 50 nm to 15  $\mu\text{m}$ .
- 30       11.       The particle of claim 1 wherein at least one said segment is comprised of material selected from the group consisting of: a metal, any metal chalcogenide, a metal oxide, a metal sulfide, a metal nitride, a metal phosphide, a metal selenide, a metal telluride, a metal antimonide, a metal alloy, a semiconductor, a semi-metal, any organic compound or

material, any inorganic compound or material, any organometallic compound or material, a particulate layer of material, and a composite material.

12. The particle of claim 11 wherein at least one of said segments is comprised of  
5 a metal.

13. The particle of claim 12 wherein said metal is selected from the group consisting of: silver, gold, copper, nickel, palladium, platinum, cobalt, rhodium and iridium.

10 14. The particle of claim 11 wherein at least one of said segments is comprised of a material selected from the group consisting of: a polymeric material, a crystalline material, a non-crystalline material, an amorphous material and a glass.

15 15. The particle of claim 1 wherein at least one of said segments is comprised of a superparamagnetic compound.

16. The particle of claim 1 wherein said particle can function as an electronic device or as part of an electronic device.

20 17. The particle of claim 16 wherein said electronic device or part of an electronic device is selected from the group consisting of a conductor, or diode, a transistor, a wire, a capacitor, a resistor, a negative differential resistance device, a resonant tunneling diode, a ferroelectric switch, a shift register and a delay line.

25 18. The particle of claim 1 wherein at least one of said segments is functionalized.

19. The particle of claim 18 wherein said functionalization comprises an organic substance, an inorganic substance, an inorganic coordination complex and/or an organometallic complex.

30 20. The particle of claim 19 wherein said functionalization comprises an organic substance.

21. The particle of claim 20 wherein said organic substance is an organic material.
22. The particle of claim 21 wherein said organic material comprises carbon, charcoal, diamond or polystyene.
- 5 23. The particle of claim 20 wherein said organic substance is an organic molecule.
- 10 24. The particle of claim 23 wherein said organic molecule comprises an antibody or antibody fragment, an oligonucleotide, an aptamer, a receptor, an enzyme, a protein, a catalyst, a catalytic antibody, a lipid, a carbohydrate, a polysaccharide, an amino acid or a peptide.
- 15 25. The particle of claim 19 wherein said functionalization comprises an inorganic coordination complex.
- 20 26. The particle of claim 25 wherein said inorganic coordination complex comprises 2-, 3-, 4-, 5-, 6-, 7-, 8- or 9- coordinate complexes.
- 25 27. The particle of claim 19 wherein said functionalization comprises an organometallic complex.
28. The particle of claim 27 wherein said organometallic complex comprises species comprised of one or more metal-carbon, metal-silicon or metal-nitrogen bonds.
29. The particle of claim 19 wherein said functionalization comprises an inorganic material.
- 30 30. The particle of claim 29 wherein said inorganic material is comprised of glass, phosphors, zeolite or oxides.
31. The particle of claim 18 wherein said functionalization comprises a detectable tag or a material which will bind a detectable tag.

32. The particle of claim 31 wherein said detectable tag is selected from the group consisting of: a fluorescent tag, an isotopic tag, a radioactive tag, a particular tag, an oligonucleotide based tag, a molecular tag, a Raman-based tag, an infrared tag, a mass spectrometric tag, and an electrochemical tag.

33. The particle of claim 18 wherein said functionalization comprises a colloidal particle, polymer, glass, molecular monolayer, molecular multilayer or film.

10 34. The particle of claim 18 wherein at least two segments are functionalized differently.

35. The particle of claim 18 wherein said functionalization is at one or both tips of said particle.

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36. The particle of claim 35 wherein said tips of said particle are functionalized differently.

37. An assembly of particles comprising a plurality of types of particles, wherein each particle is from 10 nm to 50  $\mu$ m in length and is comprised of a plurality of segments, and wherein the types of particles are differentiable.

38. The assembly of particles of claim 37 wherein said types of particles are differentiable based on differences in the length, width or shape of the particles and/or the number, composition, length or pattern of said segments.

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39. The assembly of particles of claim 37 wherein said particle types are differentiable by optical means, electrical means, physical means, chemical means or magnetic means.

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40. The assembly of particles of claim 39 wherein said particle types of are differentiable by optical means.

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41. The assembly of particles of claim 40 wherein said particle types are differentiable by differential reflectivity.
42. The assembly of particles of claim 37 wherein each said particle comprises 2 to 50 segments, and wherein the length of each particle is from 1 to 15  $\mu\text{m}$ , the width of each particle is from 30 nm to 2  $\mu\text{m}$ , and the segment lengths are from 50 nm to 10  $\mu\text{m}$ .
43. The assembly of particles of claim 37 comprising functionalized particles.
44. The assembly of particles of claim 36 comprising types of particles differently functionalized from other types of particles.
45. The assembly of particles of claim 43 wherein said functionalization comprises an organic substance, an inorganic substance, an inorganic coordination complex and/or an organometallic complex.
46. The assembly of particles of claim 43 wherein said functionalization comprises a detectable tag or a material which will bind a detectable tag.
47. The assembly of particles of claim 46 wherein said detectable tag is selected from the group consisting of: a fluorescent tag, an isotopic tag, a radioactive tag, a particulate tag, an oligonucleotide-based tag, a molecular tag, a Raman-based tag, an infrared tag, a mass spectrometric tag, and an electrochemical tag.
48. A composition comprised of a particle and a functional unit wherein said particle comprises a plurality of segments and has a length of from 10 nm to 50  $\mu\text{m}$ .
49. The composition of claim 48 wherein said particle length is from 500 nm to 30  $\mu\text{m}$ .
50. The composition of claim 48 wherein said particle length is from 1 to 15  $\mu\text{m}$ .

51. The composition of claim 48 wherein the nature of the functional unit is encoded by the particle.

52. The composition of claim 51 wherein the nature of the functional unit is encoded based on the length, width or shape of the particle and/or the number, composition, length or pattern of segments.

53. The composition of claim 48 wherein the functional unit comprises an analyte-specific species.

54. The composition of claim 48 wherein said functional unit comprises an organic substance, an inorganic substance, an inorganic coordination complex and/or an organometallic complex.

15 55. As assembly of particles comprising a plurality of types of particles, wherein each particle has at least one dimension less than 10  $\mu\text{m}$ , and wherein the types of particles are differentiable.

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20 56. The assembly of particles of claim 55 wherein each particle has at least one dimension less than 500 nm.

57. The assembly of particle of claim 55 wherein each particle has at least one dimension less than 200 nm.

25 58. The assembly of particles of claim 55 comprising at least 3 types of particles.

59. The assembly of particles of claim 55 comprising at least 5 types of particles.

30 60. The assembly of particles of claim 55 wherein said types of particles are differentiable based on differences in the length, width, shape and/or composition of the particles.

61. The assembly of particles of claim 55 comprising functionalized particles.

62. The assembly of particles of claim 61 comprising types of particles differently functionalized from other types of particles.

5 63. The assembly of particles of claim 61 wherein said functionalization comprises an organic substance, an inorganic substance, an inorganic coordination complex and/or an organometallic complex.

10 64. The assembly of particles of claim 61 wherein said functionalization comprises a detectable tag or a material which will bind a detectable tag.

15 65. A composition comprised of a particle and a functional unit wherein said particle has at least one dimension less than 10  $\mu\text{m}$ , and wherein the nature of the functional unit is encoded by the particle.

66. The composition of claim 65 wherein said particle has at least one dimension less than 500 nm.

20 67. The composition of claim 65 wherein said particle has at least one dimension less than 200 nm.

68. The composition of claim 65 wherein the nature of the functional group is encoded based on the length, width, shape and/or composition of the particle.

25 69. A method for encoding information about a material into said material comprising:

incorporating with or attaching to said material a free-standing particle that encodes information regarding said material, said particle comprising a plurality of segments, wherein the particle length is from 10 nm to 50  $\mu\text{m}$  and the particle width is from 5 nm to 50  $\mu\text{m}$ ; and wherein said encoded information is based on the length, width or shape of the particle and/or the number, composition, length or pattern of segments.

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70. The method of claim 69 wherein said encoded information relates to the composition of the material.

71. The method of claim 69 wherein said encoded information relates to the  
5 history of the material.

72. The method of claim 69 wherein at least one of said segments is comprised of a material selected from the group consisting of: a metal, any metal chalcogenide, a metal oxide, a metal sulfide, a metal nitride, a metal phosphide, a metal selenide, a metal telluride, a  
10 metal antimonide, a metal alloy, a semiconductor, a semi-metal, any organic compound or material, any inorganic compound or material, any organometallic compound or material, a particulate layer or material, and a composite material.

73. A method for conducting an assay to an analyte, comprising:  
15 contacting a solution that may contain said analyte with a composition comprising a species capable of binding said analyte and a particle comprising a plurality of segments, wherein said particle length is from 10 nm to 50  $\mu$ m and the particle width is from 5 nm to 50  $\mu$ m; and  
detecting whether interaction between said species and said analyte has  
20 occurred.

74. The method of claim 73 wherein the particle encodes the nature of said species.

75. The method of claim 74 wherein the nature of the species is encoded based on the length, width or shape of the particle and/or the number, composition, length or pattern of segments.  
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76. The method of claim 73 wherein said species comprises an antibody or  
30 antibody fragment, an oligonucleotide, an aptamer, a receptor, an enzyme, a protein, a catalyst, a catalytic antibody, a lipid, a carbohydrate, a polysaccharide, an amino acid or a peptide.

77. The method of claim 73 wherein at least one of said segments is a material selected from the group consisting of: a metal, any metal chalcogenide, a metal oxide, a metal sulfide, a metal nitride, a metal phosphide, a metal selenide, a metal telluride, a metal antimonide, a metal alloy, a semiconductor, a semi-metal, any organic compound or material, any inorganic compound or material, any organometallic compound or material, a particulate layer or material, and a composite material.

78. The method of claim 73 wherein said detection occurs by optical means, physical means, chemical means, electronic means or magnetic means.

79. The method of claim 73 wherein said particle is attached to a plurality of species capable of binding different analytes.

80. The method of claim 73 wherein said analyte is a protein or peptide.

81. The method of claim 73 wherein said analyte is an oligonucleotide.

82. A method for simultaneously conducting a plurality of assays to a plurality of analytes comprising:

contacting a solution that may contain said analytes with a plurality of compositions, wherein each composition comprises a species capable of binding to one of said analytes and a particle comprising a plurality of segments; wherein the particle length is from 10 nm to 50  $\mu$ m and the particle width is from 5 nm to 50  $\mu$ m; and wherein the nature of each species is encoded by the particle to which it is bound; and

detecting which interactions have occurred.

83. The method of claim 82 wherein at least one of said species is an antibody or antibody fragment.

84. The method of claim 82 wherein at least one of said species is an oligonucleotide.

85. The method of claim 82 wherein at least one of said segments on each of said particles is comprised of a material selected from the group consisting of: a metal, any metal chalcogenide, a metal oxide, a metal sulfide, a metal nitride, a metal phosphide, a metal selenide, a metal telluride, a metal antimonide, a metal alloy, a semiconductor, a semi-metal,  
5 any organic compound or material, any inorganic compound or material, any organometallic compound or material a particulate layer or material, and a composite material.

86. The method of claim 82 wherein the nature of each species is encoded based on the length, width or shape of the particle and/or the number, composition, length or pattern  
10 of segments.